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AUTHOR Anwar, Sohail; Favier, Patrick; Ravalitera, Guy
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ABSTRACT

This paper describes a collaboration in engineering project design and curriculum development between the Institut Universitaire de Technologie (IUT) housed in the Bethune campus of Universite d'Artois in France and the Altoona College of The Pennsylvania State University (Penn State Altoona). This collaboration embraces engineering design projects conducted by students, faculty exchanges, short-term industrial placements, and joint curriculum development. The paper provides a description of all the present and future components of the French-American collaboration. The engineering design projects conducted by the student teams at IUT Bethune and Penn State Altoona are also discussed. The paper also describes the obstacles encountered by both IUT Bethune and Penn State Altoona in carrying out the collaborative activities. Finally, the paper describes present success and future promises of the collaboration between the two universities. (Author)

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An International Collaboration in Engineering Project Design and Curriculum Development: A Case Study

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ANWAR, Sohail[1], FAVIER, Patrick[2], & RAVALITERA, Guy[3]

[1] Penn State Altoona, USA sxa15@psu.edu
[2] IUT Bethune, France Patrick.Favier@iut-geii.univ-artois.fr
[3] IUT Bethune, France Guy.Ravalitera@iut-geii.univ-artois.fr

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Abstract: *This paper describes a collaboration in engineering project design and curriculum development between the Institut Universitaire de Technologie (IUT) housed in the Bethune campus of the Université d'Artois in France and the Altoona College of The Pennsylvania State University (Penn State Altoona). This collaboration embraces engineering design projects conducted by students, faculty exchanges, short-term industrial placements, and joint curriculum development. The paper provides a description of all the present and the future components of the French-American collaboration. The engineering design projects conducted by the student teams at IUT Bethune and Penn State Altoona are also discussed. The learning experiences gained from the French-American collaborative activities are discussed. The paper also describes the obstacles encountered by both IUT Bethune and Penn State Altoona in carrying out the collaborative activities. Finally, the paper describes present success and future promises of the collaboration between the two universities.*

Keywords: *collaborative activities, faculty exchanges, French-American collaboration, engineering design projects, joint curriculum development.*

1 Background

Increasingly it has become obvious to leaders in education, business, and government that college and university graduates in the United States are inadequately prepared for the challenges posed by global competition, especially in sectors involving the development and management of sophisticated technologies. Throughout higher education curricular revisions and study abroad programs are being introduced to remedy this shortfall. This trend to strengthen academic preparation in foreign languages and international studies, however, has had only marginal impact on the engineering curricula and even less of an impact on the education of engineering technology students.

This is unfortunate, for as organizations become more global in their operations and as technology becomes more sophisticated, American industry will need more people who can work in foreign countries. Engineering technologists with additional language skills and with an understanding of other cultures will be very valuable members of the engineering team in sales, service, maintenance, production, and installation of equipment, processes, and plants. The engineering and engineering technology graduates of The US educational institutions must be prepared to work in multicultural teams in multinational corporations, some of the education preparation they need will come from international collaborative experiences that develop abilities and familiarity with information technology, team work, international collaboration, and design methodologies in a global environment. The collaboration between Penn State Altoona and IUT Bethune, France is a unique initiative to create an early educational awareness of the global implications of engineering education through the use of international collaborative student teams and design projects, faculty exchanges, and development of common curriculum modules.

2 Introduction to IUT Bethune and Penn State Altoona

The University d'Artois is a new university in northern France. It is composed of four campuses which until the early 1990's were part of the University of Lille. Today the University d'Artois houses programs in engineering, engineering, technology, and management at its Bethune location, liberal arts and related disciplines at its campus in Arras, natural and applied sciences in Lens, and law programs in Douai . At the Bethune location the engineering programs are organized into the Institut Universataire Technologie (IUT) for the technology programs and the Institut Universataire Professionelle (IUP) for the engineering programs. As a new university in the French system the University d'Artois has a strong commitment to internationalism, which is also being directed from the Bethune location. Initial collaborations were focused on engineering and engineering technology but have since expanded to include other disciplines and locations of the university. In addition, it is important to note that both IUT and IUP graduates must satisfy a foreign language proficiency and an industrial placement component as part of their

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required curricula. For all engineering and technology majors, English is one of the required foreign languages.

Penn State Altoona is one of 24 campuses making up the Pennsylvania State University system. It is the second largest of the 24 campuses and is a full service residential campus located 42 miles from the research campus at University Park.

Penn State Altoona became a four-year college within the Pennsylvania State University system in 1997 and offers baccalaureate degrees in four majors (Bachelor of Science in Business, Bachelor of Science in Nursing, Bachelor of Science in Electro-Mechanical Engineering; and a Bachelor of Arts in Letters, Arts & Science). Penn State Altoona provides the first two years of course work for 182 Penn State undergraduate degrees.

3 The IUT-Bethune-Penn State Altoona Collaboration Model

The initial motivation of the IUT Bethune was to expand their faculty and student awareness of "American" English and culture. To this end, they have committed significant financial resources to support the travel of their faculty for short-term visits to the United States and for the limited support of Penn State engineering technology faculty for short-term visits to IUT Bethune. Because of the English language proficiency requirement in both their engineering and engineering technology curricula, they expect the US. faculty members to teach courses in English.

The initial motivation of Penn State Altoona was to develop international experiences for engineering technology faculty. Some financial support has been available from the School of Engineering Technology & Commonwealth Engineering (SETCE) of the Pennsylvania State University for this initiative, however, considerable resources have been committed in time and support by the Penn State faculty, staff, and administration.

The collaboration between IUT Bethune and Penn State Altoona involves the following developmental stages:

- Familiarization with partner Institution - During this time period, there is an exchange of key individuals associated with the partnership project. The principal objective of this exchange is to become familiar with the goals, mission, institutional facilities, and the academic programs of the partner institution.
- Identification of Common interests - During this time period, the instruction and/or research activities which can benefit from the partnership are identified.
- Development and Implementation of Collaborative Activities - During this period, the previously identified collaborative activities are conducted and evaluated.
- Development and Instruction of Common Courses - During this period, common courses, classes, seminars or workshops are developed and taught at the partner institutions.
- Joint Curriculum Development - During this time period, joint curriculum development takes place resulting in common curricula or degree programs.

The partnership between IUT Bethune and Penn State Altoona is currently at the developmental stage 3 which involves development and implementation of collaborative projects and activities.

4 Historical Overview of International Collaboration

The international collaboration between the Pennsylvania State University and the IUT Bethune was initiated in 1994 with the exchange of one faculty member each, between IUT and the University Park Campus of Penn State. Several exchanges of faculty followed and in early 1996 a Memorandum of Understanding was signed by both institutions outlining a broader range of collaborative activities including the exchange of students, the development of collaborative courses, the cooperative instruction of video conferences, and the exploration of the use of new information technologies for teaching, learning and distance education.

In 1996, three faculty members from the University Park Campus of Penn State, one faculty member from Penn State Altoona and one faculty member from Penn State New Kensington traveled to IUT Bethune to teach and observe in several departments. Two students from the University Park Campus of Penn State spent two months in industrial placements in Bethune and Lille.

Again in 1997, four faculty members from University Park and one faculty member from Altoona traveled to Bethune to teach lecture and laboratory sessions and to collaborate on a conference on the use of information technology for teaching. Two students from the University Park Campus had industrial placements in northern France. These placements were arranged through IUT Bethune. Three IUT Bethune students had industrial placements in central Pennsylvania, arranged through Penn State Altoona.

One faculty member from IUT Bethune traveled to Penn State Altoona to teach lecture and laboratory sessions on the topic of microprocessor programming and interfacing.

During the academic year 1998, two collaborative projects were conducted by IUT Bethune and Penn State. One of the projects involved collaborative design teams each consisting of three students from Penn state University park Campus and three students from IUT Bethune. The other project involved independent engineering design teams

formed at IUT Bethune and Penn State Altoona. These student teams conducted a common engineering design project.

During the Spring 1998 semester, one faculty member from IUT Bethune visited Penn State Altoona to participate in the performance evaluation of Penn State Altoona student teams working on the independent engineering design project. Also, during the Spring 1998 semester three IUT Bethune students completed industrial internships with two companies located in Altoona. During May/June 1998, three faculty members from Penn State University Park and one faculty member from Penn State Altoona traveled to IUT Bethune. They conducted a French-american seminar on the use of teams in industry and academia. They also participated in the performance evaluation of student teams at IUT Bethune involved in the common engineering design project.

5 Collaborative Activities Between IUT Bethune and Penn State Altoona: Past and Present

During May/June 1996, Professor Sohail Anwar who is the EET Department Coordinator at Penn State Altoona accompanied three faculty members from the University Park Campus and one faculty member from Penn State New Kensington, to IUT Bethune. During his two-week stay in Bethune, Professor Anwar participated in several lecture and lab sessions of the courses such as programmable logic controllers (PLCs), microprocessors, industrial electronic, and electrical machines. During the lecture sessions, he helped students in solving various engineering applications and design problems. During the laboratory sessions he helped the IUT Bethune instructors and students in organizing and conducting lab exercises. Although the medium of instruction at IUT Bethune is French, due to the English language requirement in their curricula, most of the students had no difficulty in understanding English statements. These students were able to help those who had a difficulty in understanding English. It was observed during the lab sessions that IUT students were trained to work very well individually and in pairs but not in teams each consisting of more than two members.

During the same time when the Penn State faculty members visited IUT Bethune, two engineering students from the University Park Campus started two-month industrial placements in Bethune and Lille. These internships were arranged through IUT Bethune. Room, board, and local transportation for the students were provided as a minimum by the French employers. These students had some conversational abilities in French because they had taken at lease one undergraduate course in French as a part of their engineering curricula at Penn State. The students gained valuable practical experience while working in the French manufacturing organizations.

In April 1997, an IUT Bethune faculty member, Professor Ravalitera, who teaches microprocessors and control system courses at IUT visited Penn State Altoona for two weeks upon invitation from Professor Anwar. All the expenses associated with Professor Ravalitera's visit to Penn State Altoona were fully covered by IUT Bethune. During his visit, Professor Ravalitera taught a portion of Professor Anwar's microprocessors class. This course is a required course for the students in the BSEMET (BS in Electro-Mechanical Engineering Technology) program of Penn State Altoona. Professor Ravalitera has a very good command of the English language and he taught both the lecture sessions and the lab sessions in English. By conducting the class sessions and the laboratory sessions of Professor Anwar's microprocessors course for two weeks, Professor Ravalitera gained first-hand knowledge of the skills, attitudes, and abilities of the Penn State Altoona BSEMET program students. He closely observed the teamwork done by the Penn State Altoona students to complete the laboratory projects assigned to them. He also gained a working knowledge of the MOTOROLA 68000 microprocessor simulator used by the Penn State Altoona students in the microprocessors course. Professor Ravalitera introduced the Penn State Altoona students to the MOTOROLA 6809 microprocessor simulator used by him to teach microprocessors at IUT Bethune.

During the time when Professor Ravalitera visited Penn State Altoona, three engineering students from IUT Bethune started six to eight weeks long industrial internships at Conrail and the Altoona Hospital, two of the major employers in Altoona, Pennsylvania. These internships were arranged through Penn State Altoona. The internships did not carry any stipend for students. IUT Bethune paid for a major portion of room and board expenses for these students through a European Community (EC) grant. Penn State Altoona paid for the air transportation of these students from and to IUT Bethune. The three IUT Bethune students who completed the industrial internships in Altoona participated in various activities at Penn State Altoona. They attended several class sessions of the various engineering and French courses taught at Penn State Altoona. They developed valuable contacts with several Penn State Altoona faculty members and numerous Penn State Altoona students. As a result of the industrial internships and participation in activities at Penn State Altoona, the IUT students were able to develop an understanding not only of the American industrial environment but also of the social and cultural environment.

Professor Anwar from Penn State Altoona visited IUT Bethune in May 1997 along with four faculty members from the University Park Campus of Penn State. He participated in several lab sessions of Professor Ravalitera's microprocessors course in addition to some of the class and lab sessions of the power electronics course taught at IUT. Professor Anwar also participated in a conference on the use of information technology in engineering and higher education organized and taught by the faculty members from the University Park Campus who were visiting IUT at that time.

During Professor Anwar's visit to IUT Bethune in May 1997, the collaborative activities to be carried out by Penn State Altoona and IUT Bethune were planned. It was decided that during the Fall 1997 semester, a practical engineering

design project to be conducted by student design teams both at Penn State Altoona and IUT Bethune would be identified by Professors Anwar, Ravalitera and Favier. Professor Favier teaches programmable logic controllers in the electrical engineering department of IUT Bethune. It was also decided that Professor Anwar would provide the necessary training in team building, teamwork, and team performance evaluation to Professors Ravalitera and Favier who would in turn provide this training to their students at IUT Bethune working on the engineering design project.

During the Fall 1997 semester, a practical engineering design project to be conducted at IUT Bethune and Penn State Altoona was identified by Professors Anwar, Ravalitera, and Favier. The project was titled "Soft Drink Vending Machine Controller: Design and Implementation". The design specifications for the vending machine controller to be built by the electrical engineering technology students at Penn State Altoona were as follows:

A simple soft drink vending machine is to be designed in conformance with the following specifications:

- The machine dispenses only two types of drink, cola and diet cola.
- The machine accepts only quarters and dimes.
- The machine is equipped with an unlimited number of nickels.
- The cost of each drink is $0.35.
- The machine is to display the current input value.
- A reject button is to be present.
- The machine is to give correct change when the input value exceeds the cost of the drink.

The design specifications for the vending machine controller to be built by the electrical engineering students at IUT Bethune were as follows:

A soft drink dispensing machine is to be designed to meet the following specifications:

- The cost of the drink should be 5 French Franks (FF).
- A reject button should be present.
- The machine should give the correct change when the input value of the coins is more than the cost of one drink.
- The machine is to accept only 1FF, 2FF, 5FF and 10FF coins.
- A piston should be present to block the coin slot once enough money has been inserted.
- It is assumed that the vending machine is equipped with an unlimited supply of all three types of coins.

It was decided that Professor Ravalitera's students would design and implement the vending machine controller using Motorola 6800 8-bit microprocessor. Professor Anwar's students would make use of hardwired digital electronics to construct the controller. Professor Favier's students would be required to build a vending machine controller using Telemecanaque TSX-47 Automate PLC (programmable logic controller) based system and PIC-16C71 microcontroller system. The reasons for building the vending machine controller using different tools (microprocessors, hardwired digital electronics, microcontrollers and programmable logic controllers) were as follows:

1. The engineering design project would serve as the capstone project for the classes taught by Professors Anwar, Ravalitera, and Favier. It is worthwhile to mention again that Professor Ravalitera teaches microprocessor design class, Professor Anwar teaches digital electronics and microprocessor design classes, and Professor Favier teaches programmable logic controller (PLC) and microcontroller classes.
2. Conducting a common engineering design project using different technologies would allow students to compare the levels of system performance that can be realized from the use of these technologies.

During the Fall 1997 semester Professor Anwar used e-mail, fax, and regular mail to provide training to Professors Ravalitera and Favier in team development skills. The training materials were based on the content presented in [1]. Professors Ravalitera and Favier used these materials to develop handbooks for their students to provide them training in team development skills. Material presented in [2] - [5] was also used to develop the student handbooks.

During the Spring 1998 semester, Professor Anwar formed teams, each consisting of 4 students, in his digital electronics class (EET 120).These students were the first-year electrical engineering technology (2EET) majors at Penn State Altoona. Professor Ravalitera formed teams, each consisting of two students. These students were the electrical engineering majors at IUT Bethune. Professor Favier formed two teams each consisting of two European students completing ERASMUS and TEMPUS programs. One of the teams decided to use PIC microcontroller to design and implement the vending machine system. The other team decided to use a TSX programmable logic controller (PLC) system programmed in GRAFCET language. Following a strong emphasis on the development of team skills including such topics as working in teams, developing collaborative solutions, dealing with difficult team members, and evaluation of team colleagues, students teams both at IUT Bethune and at Penn State Altoona started working on the vending machine project. The Penn State Altoona student teams used hardwired digital logic to design and implement the vending machine controller. The Penn State Altoona student teams completed the vending machine project in the last week of April. Their performance was evaluated using the team evaluation instruments described in [1]. Professor Favier traveled to Altoona in April 1998 to join Professor Anwar in evaluating the team performance at Penn State Altoona. Professor Ravalitera's students used Motorola 6800 microprocessor system to develop the

vending machine controller. They completed their work in May 1998. Professor Favier's European students completed their work in June 1998. Professor Anwar traveled to Bethune in June 1998 to join Professors Ravalitera and Favier in evaluating the performance of student teams at IUT Bethune. Professors Anwar and Favier also presented a seminar on teamwork in industry and academia in June 1998 at IUT Bethune. At this seminar they presented papers on team building, teamwork, and team performance evaluation. They also described the results of vending machine design and implementation project.

During the academic year 1998 - 1999, the vending machine project described above was once again conducted at IUT Bethune and Penn State Altoona. Again, the vending machine controller was constructed by independent student teams at both institutions. However, this time, Professor Ravalitera's students did not participate in the vending machine project. Professor Anwar's students enrolled in his PLC (programmable logic controllers) class during Spring 1999 participated in the project. They worked in teams each consisting of three students. They used Allen Bradley SLC 500 PLC to conduct the project. The PLC programming language used was ladder logic. Professor Favier's European students completing ERASMUS and TEMPUS programs are currently working on the project. They are expected to complete their work in June 1999. At that time, Professor Anwar will join Professor Favier in conducting an evaluation of teams at IUT Bethune.

6 Collaborative Activities and Projects: The Future

Two specific collaborative projects will be conducted during 1999 - 2000 to build upon the existing partnership between the Penn State Altoona and the IUT Bethune. Additional projects will be developed in the next few years. Details of each project are as follows:

Project 1 - *Collaborative Design Teams:* Professor Anwar's students taking microcontroller and PLC courses at Penn State Altoona will collaborate with Professor Favier's students at IUT Bethune. Teams of four students will be formed; each composed of two Penn State Altoona and two IUT Bethune students. All teams will be assigned a design project which comes from one of the surrounding industries of Penn State Altoona or the IUT Bethune. A series of team building and cultural awareness sessions will sensitize these cross-cultural teams to issues and concerns of their partners. The language of communication between the team members will be English, however, each team will be provided language assistance by the French Department at Penn State Altoona. Teams will communicate electronically to solve the design problem. This will include electronic mail, the world wide web, chat groups, fax, teleconferencing, and videoconferencing.

Project 2 - *Development of Common Course Modules:* Professor Anwar at Penn State Altoona and Professor Manata at IUT Bethune will collaborate through the use of electronic mail, fax, and teleconferencing to develop case study based course modules in the areas of digital electronics and automation. Case study based instructional approach is described in [6]. The course modules will be used by Professor Anwar to teach his digital electronics (EET 117) students at Penn State Altoona and will also be used by Professor Manata to teach his digital electronics and automation students at IUT Bethune. Web pages will be created based on these course modules.

7 Driving Factors

1. *A Strong Innovator Leads the Process* - The principal driver of this international collaboration has been Professor Lessene, the former Director of IUT Bethune and currently the Vice President of International Programs and Partnerships at the University d'Artois which houses IUT Bethune. His commitment to the collaboration is based on a requirement for the IUT Bethune students to gain a working knowledge of foreign languages. To fulfill this requirement, he has committed adequate financial resources to bring in faculty from other countries to teach in foreign languages, often English, about their specialties in their own countries. At the Pennsylvania State University, Professor Lessene's counterpart is Dr. Wayne Hager, the Head of the School of Engineering Technology and Commonwealth Engineering (SETCE) who has been quite successful in bringing Penn State resources into the international collaboration between IUT Bethune and Penn State.
2. *Endorsement from the Management at IUT Bethune* - The collaboration was initiated by the top management level at IUT and Penn State. At the Pennsylvania State University, the SETCE Head has had the authority to enter into this collaboration. Also, both the French Government and the Pennsylvania State University recognize the importance of international collaborations.
3. *Continuous Evaluations* - Informal assessments are conducted immediately after each activity and the planning for the next activity is carried out while the results of the previous activity are still fresh in everyone's mind. A plan for the formal assessment of the IUT Bethune-Penn State Altoona partnership is being developed. The formal assessment plan will have the following components:
    1. An assessment of the effectiveness of common student team projects at both institutions.
    2. An assessment of team teaching at both institutions during the faculty exchanges.
    3. An assessment of the short-term internships completed by Penn State students in France and the IUT Bethune students in the United States.
    4. An assessment of the other aspects of IUT Bethune - Penn State Altoona partnership in addition to the ones listed above.

8 Obstacles

1. The Penn State students who obtain industrial placements in France get paid for working in industry. The IUT Bethune students who get industrial placements in the USA usually do not get paid for their work. The industrial internship is an unpaid learning experience for them. Obviously, they would like to be paid for their work as the grant from IUT Bethune covers only a portion of their total expenses. This is a major problem for student exchanges between the two institutions.
2. Language is an issue. IUT Bethune requires all their students to gain a working knowledge of two foreign languages. Penn State tends not to recognize either the utility of working knowledge or profession specific language skills.
   The French language skills of Penn State faculty are also a problem. Of the five faculty members who visited IUT Bethune in 1997, one is an expert in French, two have rudimentary skills, and two have none.
3. Information technology has also been an issue. The telephone and FAX is the preferred mode at IUT, but by 11:00 AM EST they are leaving their offices. At Penn State e-mail is extensively used. The Internet was initially resisted in France. This has now changed and IUT got its first Internet lab in the beginning of 1997.

9 Conclusions

International collaboration between IUT Bethune and Penn State Altoona was described in this paper. The collaborative activities span faculty exchanges, industrial internships for students, joint conferences, and team based design projects. The key factors driving this collaboration were described. The obstacles which still need to be overcome were briefly discussed. It is expected that despite all the obstacles, this international collaboration will continue to grow and more innovative collaborative activities will be carried out in the years to come.

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